CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter describes the procedure that was used to design, develop and evaluate the effectiveness of the Programmed Instructional Material, specifically Learn it Yourself (LIY) Reflection. The attitudes of the pupils towards using LIY Reflection and the time taken to complete the programme were also investigated. LIY Reflection is basically a branched program with knowledge of results providing simple feedback information, knowledge of correct response, try-again feedback, and elaborated feedback where appropriate.

3.2 Components of the Instructional Process

The procedure that was used to design, develop and evaluate LIY Reflection was based on an adaptation of the model for the development of instructional system by Glaser (1962). The structure of the system is shown in Figure 3.1.

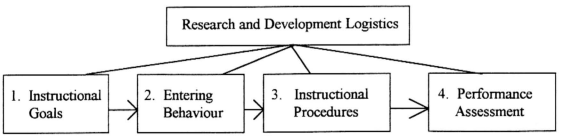

Figure 3.1: The component phases of an instructional system (Glaser, 1962)

Initially, the system was developed with the specification of the goals of instruction in mind. These goals constituted the objective to be accomplished and the purpose for which the system was to be designed. The main input into the system, upon which it is designed to operate, consisted of the entering behaviour of the pupil. The next phase constituted the actual instructional procedures and experiences which were employed to guide and modify behaviour. The final phase was the assessment of the extent to which the terminal behaviour has been achieved by the pupil as specified in the instructional goals.

3.3 Structure of Learn It Yourself (LIY) Reflection

3.3.1 Contents of Package

LIY Reflection is a programmed text on the topic of Reflection for Form Two pupils in the Malaysian secondary schools. The package comprises 4 lessons or Units covering seven aspects. These are:-

a. explaining the meaning of Reflection,

b. determining the image using tracing paper,

c. determining the axis of Reflection by folding/overlapping,

d. determining the properties of objects and images under Reflection,

e. constructing the image when the object and axis of Reflection are given,

f. constructing the axis of Reflection when the object and image are given, and

g. writing the co-ordinates of images under Reflection.

The concepts covered can be summarised as in Figure 3.2.

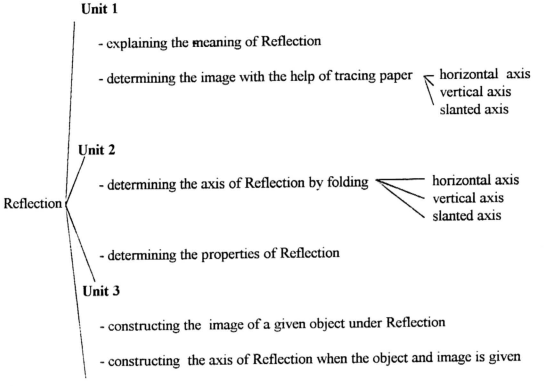

Figure 3.2: The sequence of concepts covered in the programmed text

Each Lesson or Unit is expected to take about 20 minutes. It is meant to be used individually or as a substitute for traditional instruction and also for reviewing purposes. The lesson is accompanied by a user guide (*panduan pengguna*). The guide contains an introduction to LIY Reflection and the method of using it.

3.3.2 Contents of Lesson

The contents of the lesson are as follows:-

a. Explaining the meaning of Reflection

This is an introductory section which gives the definition of Reflection.

b. Determining the image using tracing paper

This aspect covers axes of Reflection which are horizontal, vertical and slanted on both graph as well as blank paper. The objects and images are usually single points, flag heads, line segments and triangles.

c. Determining the axis of Reflection by folding/overlapping

The horizontal, vertical and slanted axes of reflection are covered in this unit. The axis of Reflection is obtained by mapping the object onto the image. Objects and images are given on blank paper. This unit also covers axis of Reflection passing through invariant point(s).

d. Determining the properties of objects and images under Reflection

This section covers five basic properties of objects and images under Reflection. The properties are:

1. Objects and images have the same shapes.
2. Objects and images have the same sizes.
3. Objects and images have opposite orientation.
4. Points at the axis of Reflection do not change their locations - invariant points.

5. The axis of Reflection is the perpendicular bisector of the chord between an object and its image.

e. Constructing the image when the object and axis of Reflection are given

This section uses slanted axis of Reflection. Guided questions are given on blank paper so that construction can be done on the blank paper itself. Most of the objects referred to are triangles.

f. Constructing the axis of Reflection when the object and image are given

This section covers both the vertical as well as the slanted axes of Reflection. Objects used are triangles as well as flag heads. Guided questions are given on blank paper so that construction can be done on the blank paper itself.

g. Writing the co-ordinates of images under Reflection

Guided questions are given on graph paper. This unit covers single points, line segments and triangles. Vertical, horizontal and slanted axes of Reflections are used.

3.3.3 Lesson Structure

Initially, the user of LIY Reflection has to attempt the Pre-requisite Test followed by Pre-test Unit 1. The user then proceeds to programmed text Unit 1, followed by the Post-test 1 and this sequence is repeated until the user has finished with Post-test 4. Lastly, the user has to fill up a feedback questionnaire.

The lesson structure is summarised in Figure 3.3.

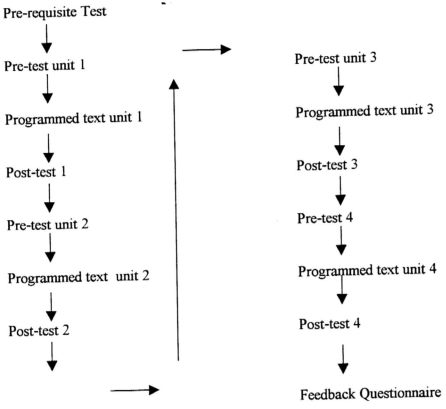

Figure 3.3: Lesson Structure

3.4 Design and Development of Learn It Yourself (LIY) Reflection

The development of LIY Reflection follows three steps. Firstly, the goals were defined. Secondly, resource materials were collected and reviewed to help in the production of lessons. Thirdly, the text had to be sequenced.

3.4.1 Defining the Goals

Based on the content of the Form Two Reflection syllabus, the goals of LIY Reflection are defined as:

a. finding images by using tracing paper, the construction method and stating of the co-ordinates.

b. determining the axis of Reflection by using tracing paper and the construction method.

c. determining the properties of Reflection.

To attain the goals, related activities are identified:

a. - finding images using tracing paper with respect to the vertical, horizontal and slanted axes,

- determining the image by using the construction method with respect to the vertical, horizontal and slanted axes,

- determining the image by stating the co-ordinates with respect to the vertical, horizontal and slanted axes.

b. - determining the axis of Reflection by folding/overlapping to image with respect to the vertical, horizontal and slanted axes,

- determining the axis of Reflection by using the construction method with respect to the vertical, horizontal and slanted axes.

c. - determining the properties of Reflection which include:

i. objects and images have the same shapes, sizes and opposite orientation,

ii. points on the axis of Reflection are invariant points, and

iii. the axis of Reflection is the perpendicular bisector of the chord between an object and its image.

3.4.2 Behavioural Objectives of Each Lesson/Unit

Following the goals, subgoals of 3.4.1 and the guidelines of the school syllabus, the programmed text was prepared. After each unit the pupils should be able to:

Unit 1: determine the image of an object under Reflection by using tracing paper with respect to the horizontal, vertical and the slanted axes.

(from goals and subgoals a)

Unit 2: determine the axis of Reflection by using the folding method and determine the properties of objects and images under Reflection.

(from goals and subgoals b and c)

Unit 3: construct the image when the object and axis of Reflection are given and construct the axis of Reflection when the object and image pair are given.

(from goals and subgoals a and b)

Unit 4: determine the co-ordinates of the reflective image of a point.

(from goals and subgoals a)

Once the goals, subgoals and behavioural objectives were defined, the programmed text was prepared. The tables of specifications of the pre-test and the post-test and the flowcharts for each unit was then prepared.

3.4.3 Table of Specifications

Tables of specifications were planned for the preparation of the pre-test and the post-test. Five tables of specifications were drawn. The Table of Specifications of the Pre-test and Post-test Unit 1 is as shown in Table 3.1.

Table 3.1: Table of Specifications of the Pre-test and the Post-test Unit 1

Objectives: To determine the image when the object is given and the axis of reflection is	Categories A	B	C	D	Total number of questions.
1. vertical			Q1a, Q1b, Q4		1.5
2. horizontal			Q2		1
3. slanted			Q1c, Q1d, Q3, Q5		2.5
Total			5		5

Key

A - comprehension
B - computation
C - application
D - analysis
Q - question

Panta et. al (1988) used the above categories for their test questions. The same categories were used for all the tests in this study. Tables of specifications were prepared for the Pre-requisite Test, Pre-test/Post-test Unit 2, Pre-test/Post-test Unit 3 and Pre-test/Post-test Unit 4. They are in Appendices 1a, 1b, 1c and 1d.

3.4.4 Sequencing the Text

Four flowcharts were drawn depicting the sequencing of each lesson/unit of the text. The flowcharts follow 2 types of branching methods. For example, in Unit 1 (Figure 3.4), the student first attempts page one which has 3 multiple choice answers. If he answers correctly, he proceeds to page 5. If he responds incorrectly, he either goes to page 10 or page 14 where he will go through some remedial steps before returning to page 1 to try again. Similar procedures are followed until he reaches Post-test 1. Programmed text Unit 2 uses the same branching style and is shown in Appendix 2a.

The numbers below indicate the frames or page numbers of the programmed text.

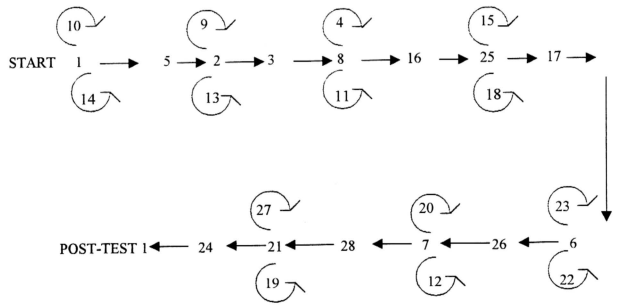

Figure 3.4: Flowchart of Unit 1

Alternatively, the branching can follow another pattern for example in Unit 3 (Figure 3.5). The student attempts his first question at page 15 which has 3 multiple choice answers. If he answers correctly, he goes to page 4 and then to page 6. However, if he answers incorrectly, he goes through remedial steps either at page 7 or page 9 and then straight on to page 6. Similar procedures are followed until he reaches Post-test 3. Programmed text Unit 4 uses the same branching style and is shown in Appendix 2b.

The numbers below indicate the frames or page numbers of the programmed text.

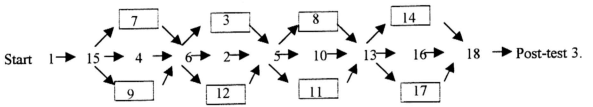

Figure 3.5: Flowchart of Unit 3

With the tables of specifications and the flowcharts, the questions and text units were planned and prepared. The user guide (*panduan pengguna*) was also produced for clarification. The programmed instructional material LIY Reflection is in Appendix 3.

3.4.5 Assessment

To assess the performance of the students, the pre-requisite test, the pre-tests and the post-tests were prepared. Similar procedures were used to design the tests for each unit. After Post-test 4, the pupils will have to answer a feedback questionnaire. The tests and the feedback questionnaire are given in the programmed text (Appendix 3).

3.5 Implementation of Instrument

This is an experimental study. The design of the study is the pre-test-post-test type. Two groups or classes were involved in this study. There was one experimental group and one control group. The pupils were selected based on the criteria that they had scored more than 60% in the Pre-requisite test and with marks less than 40% in their semester one Mathematics test or in the school monthly test.

Pre-test Unit 1 was given to all the pupils involved in the study. The experimental group was given instructions in using the programmed text, that is LIY Reflection while the control group followed the normal class instruction in Reflection taught by the investigator personally. As soon as the pupils had finished LIY Reflection Unit 1/normal class instruction, the Post-test 1 was administered immediately, that is on the same day. This procedure was repeated three times until they had completed Post-test 4. After Post-test 4, the pupils were asked to answer a feedback questionnaire.

The study was conducted during normal school hours and according to the school time-table. The study took about two weeks to complete. The details of the subjects and tests are discussed in the succeeding Sections. The design of the study is summarised in Table 3.2.

Table 3.2: Experimental Design

Group	Pre-test	Instructional Strategies	Post-test	Response towards LIY
Experimental	*	LIY	*	*
Control	*	NCI	*	~

Key

* - test or questionnaire administered
LIY - Learn It Yourself (LIY) Reflection, programmed instructional material
NCI - Normal Class Instruction
~ - questionnaire not administered.

3.6 The Sample

The sample in this study comprised Form Two pupils from a rural secondary school. The school is classified as a rural school according to the list of Rural and Urban Secondary Schools in Selangor prepared by the Education Planning, Research and Development Board (EPRD). The pupils were mostly from the working classes that is, the lower social economic status group. The pupils in the sample included Malays, Chinese and Indians.

A total of 72 pupils were involved in this study. The medium of instruction in the school is Bahasa Malaysia. The subjects consisted of 41 boys and 31girls. The national educational policy allows pupils to be promoted automatically each year and children can only be first admitted into school when they reach the age of seven, there is little variation in the age among the pupils in the sample.

Two groups of students were involved in the study. They were the experimental group and the control group. As LIY Reflection is programmed for the low

achievers in Mathematics, the selection of pupils was based on the criteria that they had scored less than 40% in their semester one Mathematics test or in the school monthly test. However, to ensure that the target group selected could follow the programmed instructional material, a Pre-requisite Test was designed to ensure that the group to be selected had basic reading and Mathematics skills. As such a minimum score of 60% in the Pre-requisite test was the cut off point. To minimise disruption to the school system, all the pupils in the classes concerned were taken. The two groups of pupils were classified into ethnic groups as shown in Table 3.3.

Table 3.3: Number of Students in Experimental and Control Groups Categorized by Race and Sex

Group	Malay		Chinese		Indian		Others		Total
	M	F	M	F	M	F	M	F	
Exp.	15	11	3	4	1	0	1	0	35
Con.	15	9	3	4	3	3	0	0	37
Total	30	20	6	8	4	3	1	0	72

Key

Exp. - Experimental
Con. - Control

The experimental group consisted of 35 pupils with 20 boys and 15 girls. The control group comprised 37 pupils with 21 boys and 16 girls. It can be seen from the table above that the ratio among the sexes is about the same for both the experimental and the control groups. In both groups, more than 50% of the pupils were Malays. The other

ethnic groups were Chinese and Indians with the exception of one Eurasian boy. The ratio among the ethnic groups are about the same for both the experimental as well as the control groups. Precaution has been taken to ensure that the experimental and the control groups are as similar as possible.

Both the experimental and the control groups sat for the Pre-requisite Test. Their performance was compared and shown in Table 3.4.

Table 3.4: Comparison of Pre-requisite Test Performance of Experimental and Control Groups using Group t-test

	Experimental Group n=35	Control Group n=37	t	df	p
Mean	74.23	73.46	0.319	70	no sig. dif. at $p < 0.05$
Standard deviation	10.79	9.65			

From the results in Table 3.4, the Pre-requisite Test mean score of the experimental and control groups is 74.23 and 73.46 respectively. Their standard deviation is 10.79 and 9.65 respectively. There is no significant difference in the Pre-requisite Test performance of the pupils from both the experimental and control groups at p=0.05. Hence, it appears that these pupils have the similar Pre-requisite.

3.7 Validity of the Text and the Tests

A panel of six experienced secondary school Mathematics teachers (Appendix 5) were requested to check on the content validity of the programmed text and the tests.

These Mathematics teachers have at least seven years of teaching experience. The teachers answered a feedback form (*maklumbalas guru* - Appendix 6) and were given about a week to respond.

Each teacher was interviewed individually after answering the feedback form. During these interviews, the comments and suggestions of these teachers were studied and discussed. Some of the comments made are listed in Table 3.5.

Table 3.5: Feedback from the Teachers/Judges

PROGRAMMED INSTRUCTIONAL MATERIALS & TESTS	RESPONSES OF TEACHERS	
	Yes	No
1. The content when compared with the school syllabus is - sufficient	6	0
- accurate	6	0
Comments: All six teachers were of the opinion that the text should be unitised so that it may be more suitable to weaker students.		
2. The language used - can be understood	6	0
The terms used - accurate	6	0
3. Sequence/Flow - good	6	0
Comments: One of the teachers suggested that wrong answers given by students be used to assist them identify their mistakes.		
4. Diagrams - confusing	0	6
- interesting	6	0
- relevant	6	0
Comments: Two of the teachers suggested that gridlines be taken from graph paper or square lined paper instead of drawing them using the computer. This is to ensure better quality diagrams. They also suggested that crosses for points be made smaller so that the diagrams appear neater.		
5. General Comments: Three teachers suggested that a simpler, modified form be done on other mathematical topics as well. Two teachers were of the opinion that these modules can be used as teaching aids in the classroom.		

The responses of the teachers were considered and modifications were made on LIY Reflection. For example, the programmed text was unitised and square lined paper was used as suggested. The final programmed text, LIY Reflection is given as in Appendix 3.

3.8 The Pilot Test

To minimise poor phrasing, ambiguities, or any possible defects in the text and test items, a pilot test was conducted. The package in Bahasa Malaysia was given to a class of 37 Form Two pupils of a rural school who had passed the Pre-requisite test with minimum marks of 60% and had scored less than 40% in their semester one Mathematics test or in the school monthly test. The subject teachers of both the groups preferred the investigator to conduct the sessions. Therefore, the investigator conducted the session personally. To avoid disrupting the school system, the whole class was involved in the pilot test. The pupils were briefed regarding the instructional strategy before beginning. These pupils completed the Pre-test Unit 1 in approximately 20 minutes.

The investigator also conducted the pilot test for the programmed text Unit 1 on the same day on the same group of pupils. The pupils completed the text in approximately 20 minutes. The pupils were later given the Post-test 1. The pupils could complete the test in 20 minutes. This sequence of events was repeated the next day with Pre-test Unit 2, Programmed text Unit 2 and Post-test 2. The same sequence was carried out for Unit 3 and Unit 4. On the last day, after the pupils had completed their Post-test 4, they were given the feedback questionnaire to fill up.

Based on the data collected from the observation, pilot test of the four sets of pre-test/post-test and feedback questionnaire LIY Reflection were then revised accordingly.

All the pupils who took part in the pilot test completed the units within the given time. They needed 20 minutes for each unit of the programmed instructional material. They could follow the self-instructional frames for Unit 1, Unit 2, Unit 3 and Unit 4. However, some pupils were not clear with the phrasing of questions 2 and 3 in the pre-test and post-test of Unit 2. Similar problems occurred for questions 3 and 4 of pre-test and post-test of Unit 3. In view of these, the diagrams in the respective questions had to be labelled so as to improve on the clarity of the questions. As for the feedback questionnaire, some pupils requested the second alternative to be modified. They preferred to try the programmed instructional material with the teacher around as facilitator. They felt the presence of a facilitator would be helpful in the event they run into problems. All the comments by the pupils were taken into account and the instruments were then revised accordingly. It was noted that the pupils appeared eager and keen to try this new method of learning.

3.9 Scheduling and Data Analysis

3.9.1 Scheduling

The duration of the experiment took approximately two weeks (Table 3.6). The training and testing were done in the usual setting of the classroom by the researcher herself. The pupils in the experimental group used LIY Reflection while the pupils in the control group were taught by the investigator using the chalk and talk method and the text book. All the tests were paper-and-pencil type with the occasional use of compass and tracing paper. The sessions were administered in the regular classrooms.

Table 3.6: Time Schedule for the Study

	Experimental Group	Control Group/ Normal Class
First Week:	Briefing-pupils regarding the instructional strategy.	**Unit 1** Pre-test Unit 1 NCI Unit 1 Post-test Unit 1
	Unit 1 Pre-test Unit 1 LIY Unit 1 Post-test Unit 1	**Unit 2** Pre-test Unit 2 NCI Unit 2 Post-test Unit 2
	Unit 2 Pre-test Unit 2 LIY Unit 2 Post-test Unit 2	
Second Week:	**Unit 3** Pre-test Unit 3 LIY Unit 3 Post-test Unit 3	**Unit 3** Pre-test Unit 3 NCI Unit 3 Post-test Unit 3
	Unit 4 Pre-test Unit 4 LIY Unit 4 Post-test Unit 4	**Unit 4** Pre-test Unit 4 NCI Unit 4 Post-test Unit 4
	Feedback Questionnaire	

Key

NCI ~ Normal Classroom Instruction

LIY ~ Learn It Yourself Reflection

3.9.2 Data Analysis

The mean, median, standard deviation, maximum and minimum scores on the pre-tests and post-tests were computed and compared. Group t-test was used to compare the achievement scores across groups, that is between the experimental and the control group. Comments from the feedback questionnaire of the students were reviewed.